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ASTYM® versus massage in the treatment of chronic exertional anterior compartment syndrome of the lower leg: a randomized controlled trial

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Abstract

Aim: Chronic exertional anterior compartment syndrome (ant-CECS) is a major cause of lower leg pain. Surgical fasciotomy is still the main treatment given with high success rate. Thorough physical therapy attempts as a non-operative treatment depends on manual therapy, modalities, and proper orthotic wear. Hence, there is a paucity of literature that compares the effects of two manual techniques on patients with ant-CECS. So, the purpose of this study was to compare the effects of Astym therapy and massage in patients with chronic exertional anterior compartment syndrome of the lower leg. Material and Method: This study was a prospective, randomized, single-blind, pre–post-test, controlled trial. The study was conducted at Beni-Suef University, Egypt. A total of thirty participants with chronic exertional anterior compartment syndrome pain enrolled in experimental and control groups. The outcomes were measured post-treatment to compare the effect of both interventions. Results: Mixed design MANOVA was used to compare the tested variables of interest. Post-treatment comparison showed a significant reduction in pain in favor of Astym group with significant differences in both lower extremity functional score and passive ankle dorsiflexion. ($p > 0.05$). Discussion: Pain and disability typically associated with ant-CECS reduced greatly after treatment of ant-CECS using ASTYM or massage. ASTYM treatment is more effective than massage therapy in reducing pain, improving overall functional level for patients with ant-CECS.

Keywords

Anterior Compartment Syndrome; ASTYM; Leg Pains; Massage

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Introduction

Chronic exertional anterior compartment syndrome (ant-CECS) of the lower leg occurs when the elevated pressure within a small unyielding anterior fascial compartment precipitates chronic lower leg pain [1, 2]. It constitutes 27-33% of the causative factors [3, 4]. This syndrome most commonly occurs in young adults, athletes subjected to high lower limb stresses (uphill and distance runners, basketball and football players, gymnasts and hurdlers) and military personnel where pain may briefly persist after termination of exercise [2, 5]. Symptoms either subside within minutes to hours when the activity stops or worsen over time [6].

A major revision of diagnostic criteria is necessary, and the differential diagnoses include patient's history, physical examination and if necessary radiographs, compartmental pressure measurements, arteriograms, angiography, bone scans and MRI [7]. Other diagnoses such as medial tibial stress syndrome, stress fracture, popliteal artery and common peroneal nerve entrapment may need to be excluded [1]. The anterior compartment contains the deep peroneal nerve, tibialis anterior muscle, and long toe extensors. Increased pressure in this compartment can cause signs of loss of sensation to the first web space and weakness with dorsiflexion of the toes and ankle. Physical exam may also include an assessment of gait or gait analysis because pronation is a common physical finding [8]. Because the syndrome primarily affects the venous system, arterial pulses are normally intact. To quantify the severity in patients with ant-CECS, a few investigators used visual analog scales [6, 9]. An ordinal scaled CECS specific measure has been introduced to grade the functional limitations resulting from pain provoked by CECS [9].

Fasciotomy is a surgical procedure to release the intracompartmental tension by severing the fascia covering the muscle compartment. However, a great range of surgical decompression is unsuccessful. Regarding outcome, results on operative intervention are good in the short term but these studies are limited with respect to follow up duration, involved many operative techniques, and the use of outcome measures [9]. Generally, nonsurgical treatment involves four treatment choices: massage, gait modification, chemo-denervation, and ultrasound-guided (USG) fascial fenestration [10]. Noninvasive interventions include arch support orthotics, ice massage to reduce swelling and pain, myofascial release, deep tissue massage, stretching before exercise, and training load modification [11]. These modalities are successful to modify the intra-compartmental pressures for short-term [12]. Conservative treatment methods include avoidance of running on hard terrains, footwear modification, alleviating the biomechanical techniques of running, and discontinuing the activity that elicits symptoms or decreasing the intensity of training. Massage therapy can also help alleviate symptoms by reducing the chronic muscular tension where patients are able to do more exercise without pain [11]. Astym® therapy is a manual technique with specific strokes used to enhance tissue healing, alleviate pain, and facilitate mobility hence, muscle performance improves through the application of specialized instruments that have shown evidence of stimulating soft-tissue healing [13, 14], and improving impairments such as pain, limitations in mobility, and muscle weakness that may accompany musculoskeletal pathology [15]. However, since Astym therapy and massage should theoretically reveal acceptable results, there is a dearth of literature that compare effects of these two techniques for patients with CECS. Therefore, the purpose of this study was to determine whether Astym therapy or massage applied to the lower leg would result in alleviation in pain, soft tissue mobility and ankle dorsiflexion.

Material and Method

The study was designed as a prospective, randomized, single-blind, pre–post-test, placebo-controlled trial. Ethical approval was obtained from the institutional review board at the Faculty of physical therapy, Beni-Suef University before study commencement [No: BSUPT04/25/07/2017]. The study followed the Guidelines of the Declaration of Helsinki on the conduct of human research. The study was conducted between July 2017 and November 2017.

Convenient samples of thirty patients recruited from the outpatient clinic of the faculty of physical therapy, Beni-Suef University were enrolled and assessed for their eligibility to participate in the study. All subjects of the study have read and signed an informed consent form approved by the Beni-Suef University. This study included participants diagnosed clinically with bilateral exertional anterior compartment syndrome of the lower leg. Their ages ranged from 18 to 35 years, they had ant-CECS for more than 3 months ago, with a Visual analog scale (VAS) Pain score > 4. All patients had no history of previous trauma to their legs and demonstrated normal roentgenograms of the tibia and fibula findings. Only patients with gradual cessation of the offending activity were involved. For individuals insisting on continuing their exertional activities, surgical treatment (fasciotomy) is the choice. Exclusion criteria involved medical history of hemophilia or other blood coagulation disorders, medical history of cardiovascular disease including those with previous cardiovascular surgery and uncontrolled hypertension, current use of prescription blood thinners, a history of metastatic disease, neuropathy of the lower extremity, an active infection (or taking medication for an infection), conditions affecting both lower extremities and previous treatment that included fasciotomy, massage or Astym [16]. Bilateral involvement was reported in 60% to 90% of the time.

Each patient signed a consent form after explaining the scope, objectives, and value of the study, informing them about the right to refuse or withdraw at any time, and reassuring them about the confidentiality of information. Data coding assured anonymity. Patients allocated randomly into Astym and massage treatment groups by a blinded and an independent research assistant who opened sealed envelopes containing a computer-generated randomization card. No subjects dropped out of the study after randomization.

Participants were randomly assigned into two experimental groups (Group A) received ASTYM therapy (Figure 1) and the other group (Group B) received intermittent massage (effleurage and cross fiber frictions) (Figure 2) for 8 sessions over a four-week period healing [13-15]. Physiotherapy program for both groups included ice (20 minutes), ultrasound on the lower lateral leg (5 minutes 2 days/week), with an intensity of 1.5 w/

cm^2 with a frequency of 1 Hz continuous mode of application [11], stretching before exercise (calf muscles, anterior tibial group) and strengthening exercises (dorsiflexors and evertors, core stability exercises). Exercise programs were individually designed based on the patient's examination and clinical findings. Subjects were blinded to whether they received the Astym® treatment or massage treatment intervention. After a 5-minute warm-up on a lower leg, Astym® treatment starts. End-feel assessment is an integral part of the examination as a hard end feel may be indicative of joint dysfunction or soft tissue restriction and can help guide intervention.

Figure 1. Application of ASTYM (locator) on the lower lateral leg.

Figure 2. Application of intermittent massage (effleurage and cross fiber friction) on the lower lateral leg.

The study outcomes were measured before starting the treatment program and at the end of the program. A subjective pain sensation as a primary outcome measure was assessed by scoring in the 10-point visual analog rating scale; zero indicates no pain while 10 represents the worst pain. While the secondary outcomes were the ankle dorsiflexion, lower extremity functional scale [17]. Measuring the range of motion of dorsiflexion as an objective measure is the third outcome.

Sample size and Statistical analysis

Sample size calculation prior to the study using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) reflected that the appropriate sample size for this study was n=30, which gave observed power equal to 0.85. Calculations made using alpha = 0.05, beta = 0.15 and large effect size. For comparing subject characteristics between both groups t-test was conducted. Then, normal distribution of data was checked using the Shapiro-Wilk test for all variables, hence Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed MANOVA was performed to compare within and between groups effects of treatment on VAS, functional scale and dorsiflexion ROM between the group A and B as between group comparison and between pre and post-treatment in each group as within-group comparison. Partial squared eta was considered as the effect size. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparisons. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 19 for Windows (IBM SPSS, Chicago, IL, USA).

Results

A total of 30 patients with chronic exertional anterior compartment syndrome pain enrolled in experimental and control groups (fig 3). Table 1 showed the subject characteristics of both groups. There was no significant difference between both groups with respect to the mean age, weight, height and BMI ($p < 0.05$). Also, there was no significant difference in blood pressure between groups ($p < 0.5$). Mixed MANOVA revealed that there was a significant interaction of treatment and time (Wilks' Lambda = 0.64; $F(4,25) = 3.48$, $p = 0.02$, $n^2 = 0.35$). There was a significant main effect of time (Wilks' Lambda = 0.06; $F(4,25) = 93.62$, $p = 0.0001$, $n^2 = 0.93$). There was no significant main effect of treatment (Wilks' Lambda = 0.8; $F(4,25) = 1.51$, $p = 0.22$, $n^2 = 0.19$). Table 2 showed descriptive statistics of VAS, lower extremity functional scale and dorsiflexion ROM as well as the significant level of comparison between groups and the significant level of comparison between pre and post-treatment in each group. There was no significant difference between the Group A and B in all variables pre-treatment ($p > 0.05$). Post-treatment there was a significant increase in lower extremity functional scale, right and left dorsiflexion ROM of Group A compared with that of the group ($p > 0.05$). Also, there was a significant decrease VAS of Group A compared with that of Group A post-treatment ($p > 0.05$). There was a significant increase in the lower extremity functional scale, right and left dorsi flexion ROM post treatment compared with pre-treatment in both groups ($p = 0.0001$). However, both groups showed a significant decrease in VAS post-treatment compared with that pre- treatment ($p = 0.0001$).

Adverse events

There are no adverse events occurred during the study.

Discussion

The Osseo-fascial boundary of the anterior compartment could limit the swelling of the muscle in chronic exertional anterior compartment syndrome. Fronek et al. [5] stated the presence of different mechanisms explaining the cause of this swelling. The use of a non-operative approach to the treatment of CECS would be valuable when it could prevent the risk, complications, and costs related to surgical intervention. This study de-

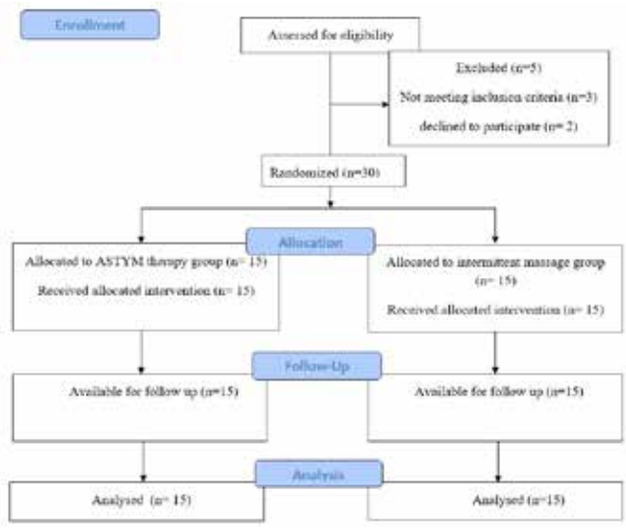

Figure 3. Flow chart of the study.

signed to compare the effects of Astym therapy and massage in patients with bilateral chronic exertional anterior compartment syndrome of the lower leg. Fronek et al. stated that the nonsurgical treatment of CECS was successful when it could prevent patients with CECS to develop an acute compartment syndrome through the ischemic producing mechanism as many acute cases with acute compartment syndrome superimposed on CECS.

There was a diversity of mechanisms precipitating muscle hypertrophy within a confined Osseo-fascial boundary. Canale et al. [18] postulated that isometric or isotonic muscle contraction, vigorous exercises through increasing muscle mass by 20%. While Brown et al. [19] explained that increased muscle blood volume was the causative mechanism. Sejersted [20] found that the compression of the interstitial fluid is another mechanism. Jacobbson et al. [21] revealed that post-exercise muscle swelling increases blood flow and fiber swelling which may reach up to 20 times more than the resting level and fluid retention. Therefore, the increase of intramuscular pressure could diminish venous return leading to capillary occlusion and consequently compartment ischemia. The ultimate Intracompartmental pressures render the muscle in the non-contractile state where the balance between intramuscular compartment pressure and the microvascular pressure determined the patency of perfusion and hence, the oxygen supply of the muscle. Scheer et al. [22] emphasized the importance of treatment type in providing tactile pressures and shear forces to stimulate tissue healing at a cellular level.

Results of the current study revealed that Astym had more pronounced effect than massage in the treatment of ant-CECS. Collins et al. [23] demonstrated that patients with CECS may have some improvement following manual therapy [24-26]. Sevier et al. [24], Laudner et al. [25] and Loghmani et al. [26] showed that Astym therapy could induce leakage from dysfunctional capillaries that ends up with increased fibroblast activity, macrophage phagocytosis, and local growth factors released that enhanced more fibroblast recruitment, reduced pain and restored function in people with musculoskeletal pathologies including epicondylosis.

The study results are consistent with the conclusion of Mc Cormack [27] who revealed significant pain reduction with the improvement of the lower limb function in the patient with high hamstring tendinopathy. The finding of Chughtai [28] proved a significant gain in knee joint ROM in patient who underwent Astym therapy compared with standardized physical therapy program following total knee arthroplasty. Chughtai [28] and Paker [29] proved that the joint pain and ROM might be related to effects of Astym on the biomechanical properties of the injured tissues with enhancement of blood flow and possible angiogenesis in the vicinity of these tissues

Patients with Ant-CECS might have transient or permanent low-grade foot drop as a result of the weakness of dorsiflexors with or without paresthesia on the dorsum of the foot. Rest or cessation of exercise relieved symptoms by 85% of athletes. The involved muscles may be tender or not relying on whether the patient is symptomatic or not. Findings of Detmer [30] revealed that the majority of patients were symptomatic. Findings of our study contradict with Diebal 2012 [3] as they confirmed the

Table 1. Comparison of the mean age, weight, height, BMI and blood pressure between Groups A and B.

	Group A	Group B			
	$\bar{x}$±SD	$\bar{x}$±SD	MD	t-value	p- value
Age (years)	25.18 ± 5.33	25.07 ± 5.69	0.11	0.05	0.95
Weight (kg)	68.24 ± 7.86	69.68 ± 6.27	-1.44	-0.55	0.58
Height (cm)	168.2 ± 6.47	167.66 ± 6.66	0.54	0.22	0.82
BMI (kg/m²)	24.08 ± 1.96	24.79 ± 1.88	-0.71	-1.01	0.31
Systolic blood pressure (mmHg)	124.73 ± 4.57	122.26 ± 3.67	2.47	1.62	0.11
Diastolic blood pressure (mmHg)	79 ± 2.85	78.8 ± 2.88	0.2	0.19	0.85

$\bar{x}$, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value

Table 2. VAS, functional scale and dorsiflexion ROM pre and post treatment in Groups A and B:

	Pre treatment			Post treatment				
	Group A	Group B		Group A	Group B		Repeated measures (Group A)	Repeated measures (Group B)
	$\bar{x}$±SD	$\bar{x}$±SD	p value	$\bar{x}$±SD	$\bar{x}$±SD	p value	p value	p value
VAS	3.18 ± 1.09	3.06 ± 0.86	0.74	1.08 ± 0.61	1.68 ± 0.85	0.03*	0.0001*	0.0001*
Functional scale	69.26 ± 5.33	68.66 ± 5.78	0.77	79 ± 1.41	74.93 ± 3.95	0.001*	0.0001*	0.0001*
Rt dorsiflexion ROM (degrees)	16.13 ± 1.84	16.26 ± 2.01	0.85	19.66 ± 0.61	18.8 ± 1.37	0.03*	0.0001*	0.0001*
Lt dorsiflexion ROM (degrees)	17 ± 1.81	16.2 ± 1.69	0.22	19.53 ± 0.91	18.4 ± 1.45	0.01*	0.0001*	0.0001*

$\bar{x}$, mean; SD, standard deviation; p-value, level of significance; * Significant

failure of non-surgical management (anti-inflammatory drugs, stretching, prolonged rest, decreasing or avoiding the problematic activity, orthotics, and massage) to address symptoms.

There are some limitations of the current study that should be recognized. The main limitation of our study was the fact that the conventional program, which was prescribed for the two groups, is already effective by itself. Therefore, the results of this study failed to prove the independent effects of Astym or massage therapy alone. In addition, this study only reported the short-term effects of ASTYM or massage, so we cannot generalize about long-term effects.

Conclusion

Pain and disability typically associated with ant-CECS reduced greatly after the treatment of ant-CECS using ASTYM or massage. ASTYM treatment is more effective than massage therapy in reducing pain, improving the overall functional level and ankle dorsiflexion for patients with ant-CECS.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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